On the Notion of a Resource

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for Master Computer Science

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Systems and Problem Solving

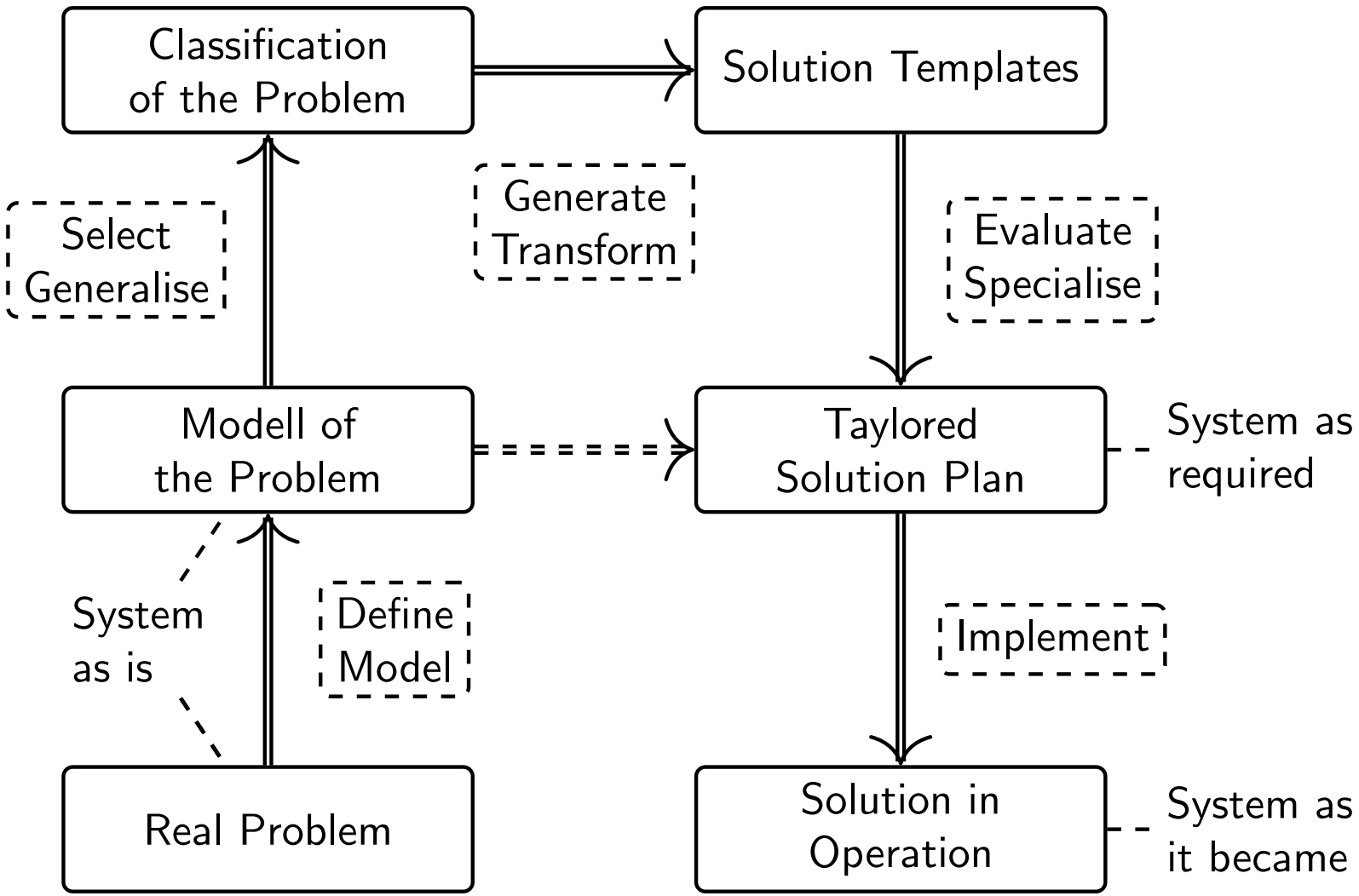
The concept of system is a basic mental tool for delimiting and reducing problems to their essentials.

Such focussing and contextualisation is the prerequisite for further planful proceeding according to Darrell Mann:

- for modelling the problematic situation ("Define"),
- for selection of suitable solution tools ("Select"),
- for generation of solution proposals ("Generate") and
- the assessment and selection of suitable solutions ("Evaluate").

D. Mann stops at this mental stage in his book, which of course must still be followed by the implementation of the solution – "it is not only about interpreting the world differently, it is a matter of changing it" (Marx).

The TRIZ Way of Thinking



Define

This first step in Darrell Mann's approach starts with the delineation of an appropriate systemic context for the study of the problem.

- Delimitation of the system externally against a "living" context as *environment*.
- Delineate the system internally – delineate *components* that either already exist (as *artefacts* or as *services*, i.e. also "belong to the environment") or are available at the time of assembling and operating the system.

This allows concentration on the *internal view* and planning of a *functional solution* to the problem.

TRIZ Concept of the Ideal Machine

In the TRIZ methodology *functional* properties as "usefulness for others" are in the foreground.

The terms *usefulness* and *harmfulness* play an important role in TRIZ alongside the objectives of profitability and efficiency as socio-cultural guiding principles.

With the concepts of *Ideality* and *Ideal Final Result* a mental construct of anticipation of the functional properties of a system stands at the beginning of its genesis.

Koltze/Souchkov, p. 40

The ideal machine is a solution in which the maximum utility is achieved but the machine itself does not exist.

TRIZ Concept of the Ideal Machine

The ideal machine is therefore *pure functionality* without any resource-related underpinning.

Nonetheless, that fictitious idea is central to TRIZ, for it develops a strong orientation towards the intended usefulness and thus has a socio-cultural guiding effect.

Machine here stands very generally for "potentially working solution" and hence applies also to problem solving in socio-technical systems as organisations.

Select, Generate, Evaluate

Here Darrell Mann deviates somewhat from my scheme.

My „Generalise“ is rather part of „Define“ but not directed towards modelling of the given problem, but at finding a *working conceptual generalisation*.

„Select“ appropriate tools requires or is interwoven with finding this working conceptual generalisation.

„Generate“ much depends on a good choice of tools and thus of a working conceptual generalisation. Hence the demarcation of the transformation on the higher level of abstraction is slightly different.

This also applies to „Specialise“. It is more than mere „Evaluation“ since it comprises to taylor a general solution template to the given situation.

In both versions the process ends with a *plan* for the implementation of the solution.

Implement

This phase does not occur in Darrell Mann's work (and in TRIZ in general) in such a clear way as it does, for example, in Design Thinking.

But the DT methodological approach is different: the methodological focus is rather on the multiple rapid (agile) passing through the feedback cycle between real problem and possible solutions instead of precise planning.

Implement

Implement in (or after) TRIZ means:

- Machine must be "built".
- Machine must be "deployed" at the given location and "come to life".
- To do this, the *operating conditions* (import and export) must be provided.
- Which resources are needed (input) and which are made available (output).

What are resources in TRIZ?

On the Notion of Resources in TRIZ

ARIZ-85C:

„Substance Field Resources are substances and fields that are already available or are (easily) obtainable according to the conditions of the task“.

Wessner lists a whole variety of concepts of resources proposed by different TRIZ schools. The spectrum ranges from

- ”a means that can be used to solve a problem” (Souchkov)
- to ”anything in or around the system that is not being used to its maximum potential” (Mann, Salamatov)
- to the notion of resource as source of a problem itself: ”a problem always arises, if a needed resource is not present” (Orlov).

On the Notion of Resources in TRIZ

In (Koltze/Souchkov, p. 51) a resource is understood as "a means, a tool to carry out an action or to make a process take place" and equipment, money funds, raw material, energy or even people (human resources) are mentioned as examples of resources.

Furthermore ressources there are classified according to

- *value* (free, not expensive, expensive),
- *quality* (harmful, neutral, useful),
- *quantity* (unrestricted, sufficient, insufficient) and
- *readiness for use* (ready, to be modified, to be developed).

Specific *qualitative* determinations of such "substances and fields" as resources play almost no role.

Qualitative determinations in the sense of the fulfilment of a *specification* are, however, essential in more complex technical contexts in order to ensure the *operation* of a specific functional property, which is to be provided by a systemic context.

What is the Problem?

The constructed thing (partial system) that has been taken out must be (re)placed in the overall context. But this context can be operated only as a *unified whole* that cannot be disassembled from an operational point of view. The whole can only be operated in an assembled state, and this requirement to be "assembled" does not end at any system boundary either.

It means putting the "dead" partial system (after appropriate preparation) into a "living" (itself being systemically structured) environment and "starting it to operate".

Preparation: In component software, a distinction is made between deploy, install and configure as well as an explicit signal to switch from preparation to operating mode.

What is the Problem?

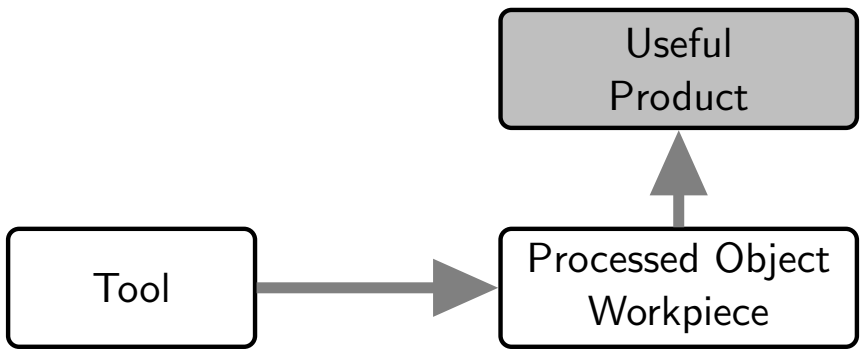
This induces a *further systemic development* of the "living" environment as a systemic complex, i.e. *the whole changes*.

This requirement later to operate the system must already be present in the entire (mental) development process.

How does this throughput of substance, energy and information appear in the TRIZ modelling process?

Operating a Minimal Technical System

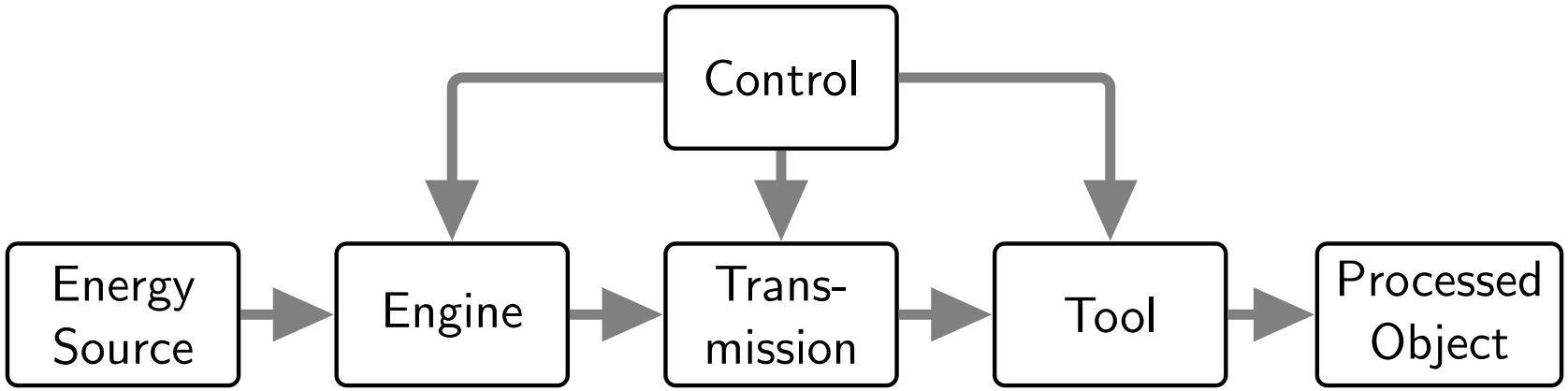
In the TRIZ notion of a *minimal technical system*, a *tool* acts on an *object* (workpiece) to be processed in order to transform it into a *useful product*.



The concept of the *ideal system* considers the tool as a purely functional property, the effect of which to intentionally change the state of the workpiece to a useful product is achieved without any additional efforts and any wear of the tool.

In other words, it is not the tool but the *imaginaton of the tool* that creates the required action in such an *ideal machine*.

Operating a Complete Technical System



In the classical understanding of a *complete technical system*

- the energy throughput is centered on the tool,
- the throughput of substance transports the workpieces
- and the throughput of information is directed to the control of the action.

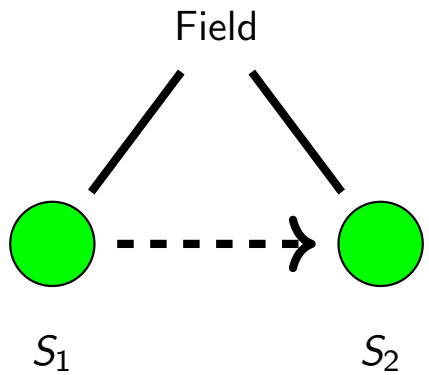
Thus, in any case, the concept of a resource is understood as "means that can be used to solve a problem."

Resources, Tools and State Changes

The understanding of the relationship of action conveyed here is asymmetrical.

An active tool has a state-changing effect on a passive workpiece, while retaining its own functionality and – ideally – without undergoing a state change itself.

In *substance-field models* this understanding is replaced by a more symmetrical model of a field-mediated action between two substances.



Resources, Tools and State Changes

At the same time, in the systemic abstraction, the materiality of the *tool* is pushed back further in favour of the concept of *action* and a component concept is prepared as proposed by C. Szyperski for Component Software.

There, *components* are basically conceptualised as *stateless* with all the resulting consequences. In contrast to this *objects* are conceptualised as state-bearing units of instantiation to maintain a certain standardisation of workpieces required for a repeated application of a function within a production process.

Resources, Tools and State Changes

A similar idea comes through when Souchkov describes the two goals of *Resource Analysis* as essential component of TRIZ:

- Analysis of the resources that are to be *treated or consumed* in the course of a process,
- and analysis of the resources that can be *used* to carry out the process or to solve the problem,

i.e., he distinguishes resources of the first kind, which undergo state-changing transformations as *workpieces* and resources of the second kind, which are used as tools to *mediate* these state changes.

Operation and Maintenance of Technical Systems

Such a notion also corresponds well with the widespread organisation of production processes, where a distinction is made between operating and maintenance mode.

In the operating mode, the focus is on the functional properties of the tool, while in the maintenance mode its material properties are focused.

As an independent technical system in a narrower sense, only the operating mode is modelled as the target of a "problem solution".

The maintenance mode is part of the supersystem, which is concerned with the *reproduction* of the tools as *resources* used in the operating mode.

Operation and Maintenance of Technical Systems

In the (classical) operating mode the focus is on the use of tools and the material throughput of workpieces, which are thereby transformed into useful products, in many cases *technical artefacts*, which are either further processed as semi-finished products in a following technical system or enter into such contexts as tools themselves.

In both cases the useful product is a *resource* for further systemic processes.

But TRIZ is not (primarily) about system analysis but about *problem solving* and the design of viable technical systems in a *systemic development* **process**.

Systemic Development and Problem Solving

Souchkov clarifies the role of *Resource Analysis* in such a process:

> *A technical system has different resources at its disposal for the completion of its function. A function can only be completed using suitable resources. Resources are therefore elementary building blocks of a problem solution. The skilful use of resources distinguishes an efficient from an inefficient system.*

The question of systemic operating conditions is thus reversed – it is not about what conditions are *required* for the operation of a particular system, but what kind of system under *given* operating conditions promises an efficient problem solution.

The focus thus shifts from the operating conditions of an existing system to the question of a systemic development and co-evolution in a given context.